REMARKS

In the Specification

The change to the specification is consistent with the actual melting temperature of tin.

Allowed and Allowable Claims

Applicant notes with appreciation that the Examiner has allowed certain claims, and has indicated that other claims would be allowable if written in independent form. Claim 1 now includes the limitation of claim 4. Claim 8 includes the limitation of claim 10. Claim 22 has been allowed by the Examiner. Claim 27 has been amended with a limitation similar to claim 4. Applicant submits that claim 27 should be allowable for at least the same reasons as claim 1. New claims 30, 31, 32, and 33 correspond respectively to claims 7, 14, 15, and 18, written in independent form. All of the other claims depend from one of these claims.

Applicant, accordingly, respectfully submits that the claims are now in condition for allowance, and respectfully requests an allowance of the patent application. If the Examiner believes a telephone conference would expedite or assist in the allowance of the present application, the Examiner is invited to call Stephen M. De Klerk at (408) 720-8300.

Please charge any shortages and credit any overages to Deposit Account No. 02-2666. Any necessary extension of time for response not already requested is hereby requested. Please charge any corresponding fee to Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Date: July 23, 2002

Stephen M. De Klerk
Reg. No. 46,503

12400 Wilshire Boulevard
Seventh Floor
Los Angeles, California 90025-1026
(408) 720-8300

VERSION OF AMENDED SPECIFICATION AND CLAIMS WITH MARKINGS TO SHOW CHANGES

In the Specification

-- **[0022]** Other materials may be used instead of the gold layer 24 to provide a wetting layer over the nickel layer 22. Such materials include tin and noble metals such as silver and palladium, or combinations of these metals. Tin, silver, and palladium have melting temperatures of [2260°C] <u>232°C</u>, 961°C, and 1552°C respectively. It was found that silver with a thickness of approximately 0.2 or less microns is optimal. It may also be possible to make the primary heat spreading structure 20 of other materials such as aluminum, and have nickel plated on the aluminum. Materials other than the pure indium 14 may also be possible, but such a material preferably has a thermal conductivity of at least 35 W/mK, although a thermal conductivity of at least 70 W/mK is much preferred. --

In the Claims

Claims 4 and 10 have been cancelled.

1. (Amended) A method of constructing an electronic assembly, comprising:

forming a wetting layer of a material other than nickel on a surface of a thermally conductive heat spreader<u>, the wetting layer being between 0.02 and 3.0 microns thick</u>;

locating a metal thermal interface material, of a different material than the

wetting layer, against a surface of the wetting layer;

locating a die having an integrated circuit formed therein against the thermal interface material;

heating the metal thermal interface material so that it melts, the material of the wetting layer promoting wetting of the metal thermal interface material over the thermally conductive heat spreader; and

allowing the metal thermal interface material to cool so that it solidifies and forms a thermal and structural couple between the die and the thermally conductive heat spreader.

2. (Amended) The method of claim 1, wherein the material of the wetting layer includes at least one of gold, silver, palladium, and tin.

3. (Amended) The method of claim 1, wherein the material of the wetting layer is gold.

5. (Amended) The method of claim [4] 1, wherein the wetting layer is approximately 0.2 microns thick.

6. (Amended) The method of claim 1, wherein the metal thermal interface material includes indium.

7. (Amended) The method of claim 1, wherein the metal thermal interface material is heated and allowed to cool before reaching a melting temperature of the wetting layer.

8. (Amended) An electronic assembly, comprising:

a thermally conductive heat spreader;

a wetting layer of a material other than nickel formed on a lower surface of the thermally conductive heat spreader, the wetting layer being between 0.02 and 3.0 microns thick;

a die having an integrated circuit formed therein; and

a metal thermal interface material of a different material than the wetting layer located on the die with a lower surface of the wetting layer on an upper surface of the metal thermal interface material, the metal thermal interface material having been heated so that it melted, and allowed to cool so that it solidified and formed a thermal and structural interface between the die and the thermally conductive heat spreader.

9. (Amended) The electronic assembly of claim 8, wherein the material of the wetting layer is gold.

11. (Amended) The electronic assembly of claim [10] 1, wherein the wetting layer is approximately 0.2 microns thick before the metal thermal interface

material is melted.

12. (Amended) The electronic assembly of claim 8, wherein a portion of the wetting layer is not located between the die and the thermally conductive heat spreader.

13. (Amended) The electronic assembly of claim 12, wherein the portion is gold, having a thickness of between 0.02 and 3.0 microns.

14. (Amended) The electronic assembly of claim 8, wherein the wetting layer is selected of a material and thickness so that the assembly can be cycled between 125°C and -55°C at least 40 times without substantial damage to an interface between the heat spreader and the interface material.

15. (Amended) The electronic assembly of claim 8, wherein the metal thermal interface material has a thermal conductivity of at least 35 W/mK.

16. (Amended) The electronic assembly of claim 15, wherein the metal thermal interface material has a thermal conductivity of at least 70 W/mK.

17. (Amended) The electronic assembly of claim 8, wherein the metal thermal interface material includes indium.

18. (Amended) The electronic assembly of claim 8, wherein the thermally conductive heat spreader includes a primary heat spreading structure and a diffusion barrier layer on the primary heat spreading structure, the diffusion barrier layer being located between the wetting layer and the primary heat spreading structure and being made of a material which prevents diffusion of the material of the wetting layer therethrough to the primary heat spreading structure.

19. (Amended) The electronic assembly of claim 18, wherein the primary heat spreading structure is made of copper.

20. (Amended) The electronic assembly of claim 18, wherein the diffusion barrier layer is made of nickel.

22. (Amended) An electronic assembly, comprising:

a substrate;

a die having an integrated circuit formed in a lower surface thereof, mounted on an upper surface of the substrate;

a thermally conductive heat spreader, including a primary heat spreading structure and a nickel diffusion barrier layer formed on a lower surface of the primary heat spreading structure;

a wetting layer formed on a lower surface of the diffusion barrier layer, the wetting layer being of a material other than nickel; and

an indium thermal interface material other than the wetting layer located on the die with a lower surface of the wetting layer on an upper surface of the indium thermal interface material, the indium thermal interface material having been heated so that it melted and allowed to cool so that it solidified, and formed a thermal and structural interface between the die and the diffusion barrier of the thermally conductive heat spreader.

23. (Amended) The electronic assembly of claim 22, wherein the material of the wetting layer is at least one of gold, silver, and tin.

24. (Amended) The electronic assembly of claim 22, wherein the material of the wetting layer is gold.

25. (Amended) The electronic assembly of claim 24, wherein the wetting layer is between 0.02 and 3.0 microns thick.

26. (Amended) The electronic assembly of claim 22, wherein the wetting layer is selected of a material and thickness so that the assembly can be cycled between 125°C and -55°C at least 40 times without substantial damage to an interface between the heat spreader and the interface material.

27. (Amended) A method of constructing an electronic assembly, comprising:

locating a die, a metal thermal interface material, a wetting layer <u>of between 0.02 and 3.0 microns thick</u> of a material other than nickel, and a thermally conductive heat spreader in sequence next to one another;

heating the metal thermal interface material so that it melts, the material of the wetting layer promoting wetting of the metal thermal interface material over the thermally conductive heat spreader; and

allowing the metal thermal interface material to cool so that it solidifies and forms a thermal and structural couple between the die and the thermally conductive heat spreader.

28. (Amended) The method of claim 27, wherein the material of the wetting layer includes at least one of gold, silver, palladium, and tin.

29. (Amended) The method of claim 27, wherein the metal thermal interface material includes indium.

30. (New) A method of constructing an electronic assembly, comprising:

forming a wetting layer of a material other than nickel on a surface of a thermally conductive heat spreader;

locating a metal thermal interface material, of a different material than the

wetting layer, against a surface of the wetting layer;

locating a die having an integrated circuit formed therein against the thermal interface material;

heating the metal thermal interface material so that it melts, the material of the wetting layer promoting wetting of the metal thermal interface material over the thermally conductive heat spreader; and

allowing the metal thermal interface material to cool so that it solidifies and forms a thermal and structural couple between the die and the thermally conductive heat spreader, wherein the metal thermal interface material is heated and allowed to cool before reaching a melting temperature of the wetting layer.

31. (New) An electronic assembly, comprising:

a thermally conductive heat spreader;

a wetting layer of a material other than nickel formed on a lower surface of the thermally conductive heat spreader;

a die having an integrated circuit formed therein; and

a metal thermal interface material, of a different material than the wetting layer, located on the die with a lower surface of the wetting layer on an upper surface of the metal thermal interface material, the metal thermal interface material having been heated so that it melted, and allowed to cool so that it solidified and formed a thermal and structural interface between the die and the thermally conductive heat spreader, wherein the wetting layer is selected of a

material and thickness so that the assembly can be cycled between 125°C and -55°C at least 40 times without substantial damage to an interface between the heat spreader and the interface material.

32. (New) An electronic assembly, comprising:

a thermally conductive heat spreader;

a wetting layer of a material other than nickel formed on a lower surface of the thermally conductive heat spreader;

a die having an integrated circuit formed therein; and

a metal thermal interface material, of a different material than the wetting layer, located on the die with a lower surface of the wetting layer on an upper surface of the metal thermal interface material, the metal thermal interface material having been heated so that it melted, and allowed to cool so that it solidified and formed a thermal and structural interface between the die and the thermally conductive heat spreader, wherein the metal thermal interface material has a thermal conductivity of at least 35 W/mK.

33. (New) An electronic assembly, comprising:

a thermally conductive heat spreader;

a wetting layer of a material other than nickel formed on a lower surface of the thermally conductive heat spreader, wherein the thermally conductive heat spreader includes a primary heat spreading structure and a diffusion barrier

layer on the primary heat spreading structure, the diffusion barrier layer being located between the wetting layer and the primary heat spreading structure and being made of a material which prevents diffusion of the material of the wetting layer therethrough to the primary heat spreading structure;

a die having an integrated circuit formed therein; and

a metal thermal interface material of a different material than the wetting layer located on the die with a lower surface of the wetting layer on an upper surface of the metal thermal interface material, the metal thermal interface material having been heated so that it melted, and allowed to cool so that it solidified and formed a thermal and structural interface between the die and the thermally conductive heat spreader.